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FEE TRANSMITTAL

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Small Entity payments must be supported by a small entity statement,
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See 37 C.F.R. §§ 1.27 and 1.28.*

TOTAL AMOUNT OF PAYMENT (\$)**2,702.00**

Complete if Known

Application Number	
Filing Date	October 17, 2000
First Named Inventor	Yasuo HIRA
Examiner Name	
Group / Art Unit	
Attorney Docket No.	500.39179X00

METHOD OF PAYMENT (check one)

1. ☐ The Commissioner is hereby authorized to charge indicated fees and credit any overpayments to:

Deposit Account Number **01-2135**

Deposit Account Name **Antonelli, Terry, Stout & Kraus**

☒ Charge Any Additional Fee Required
Under 37 CFR §§ 1.16 and 1.17

2. ☒ Payment Enclosed:

☐ Check ☐ Money Order ☒ Other

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code (\$)	Small Entity Fee Code (\$)	Fee Description	Fee Paid
101 690	201 345	Utility filing fee	710.00
106 310	206 155	Design filing fee	
107 480	207 240	Plant filing fee	
108 690	208 345	Reissue filing fee	
114 150	214 75	Provisional filing fee	

SUBTOTAL (1) (\$)**710.00**

2. EXTRA CLAIM FEES

Total Claims	Extra Claims	Fee from below	Fee Paid
89	-20** = 69	18	1242
9	-3** = 6	80	480
Multiple Dependent		270	270

**or number previously paid, if greater; For Reissues, see below

Large Entity Fee Code (\$)	Small Entity Fee Code (\$)	Fee Description
103 18	203 9	Claims in excess of 20
102 78	202 39	Independent claims in excess of 3
104 260	204 130	Multiple dependent claim, if not paid
109 78	209 39	** Reissue independent claims over original patent
110 18	210 9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) (\$)**1,992.00**

FEE CALCULATION (continued)

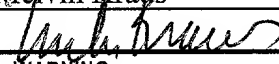
3. ADDITIONAL FEES

Large Entity Fee Code (\$)	Small Entity Fee Code (\$)	Fee Description	Fee Paid
105 130	205 65	Surcharge - late filing fee or oath	0.00
127 50	227 25	Surcharge - late provisional filing fee or cover sheet	0.00
139 130	139 130	Non-English specification	0.00
147 2,520	147 2,520	For filing a request for reexamination	0.00
112 920*	112 920*	Requesting publication of SIR prior to Examiner action	0.00
113 1,840*	113 1,840*	Requesting publication of SIR after Examiner action	0.00
115 110	215 55	Extension for reply within first month	0.00
116 380	216 190	Extension for reply within second month	0.00
117 870	217 435	Extension for reply within third month	0.00
118 1,360	218 680	Extension for reply within fourth month	0.00
128 1,850	228 925	Extension for reply within fifth month	0.00
119 300	219 150	Notice of Appeal	0.00
120 300	220 150	Filing a brief in support of an appeal	0.00
121 260	221 130	Request for oral hearing	0.00
138 1,510	138 1,510	Petition to institute a public use proceeding	0.00
140 110	240 55	Petition to revive - unavoidable	0.00
141 1,210	241 605	Petition to revive - unintentional	0.00
142 1,210	242 605	Utility issue fee (or reissue)	0.00
143 430	243 215	Design issue fee	0.00
144 580	244 290	Plant issue fee	0.00
122 130	122 130	Petitions to the Commissioner	0.00
123 50	123 50	Petitions related to provisional applications	0.00
126 240	126 240	Submission of Information Disclosure Stmt	0.00
581 40	581 40	Recording each patent assignment per property (times number of properties)	0.00
146 690	246 345	Filing a submission after final rejection (37 CFR § 1.129(a))	0.00
149 690	249 345	For each additional invention to be examined (37 CFR § 1.129(b))	0.00
Other fee (specify) _____			0.00
Other fee (specify) _____			0.00

* Reduced by Basic Filing Fee Paid

SUBTOTAL (3) (\$)**0.00**

SUBMITTED BY

Name (Print/Type) Mevin Graps	Registration No. (Attorney/Agent) 22,466	Telephone 703-312-6600	Complete (if applicable)
Signature 		Date 10/17/2000	

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OPTICAL FILM AND LIQUID CRYSTAL DISPLAY
USING THE SAME

[illegible]

BACKGROUND OF THE INVENTION

This invention relates to an optical film which is an image quality improved film and a liquid crystal display apparatus using the same.

5 Recently, image display apparatuses typified
by a liquid crystal display panel are widely used as a
display means in personal computers, work stations,
etc. As to the quality of images displayed by using
these apparatuses, high display contrast, wide angle of
10 field properties, and the like are required.

In order to realize such image quality, JP-A 6-27454 discloses a liquid crystal display installing a micro lens array wherein a light shield film is formed at corresponding positions for each lens. JP-A 6-95099 discloses the use of a rear light source having high directivity as a light source for a liquid crystal display panel, and installation of a light diffusion plate between the liquid crystal display panel and the rear light source. Further, JP-A 10-39769 discloses as a screen in a rear projection type projection apparatus, a screen wherein alignment pattern of microlens of the screen and that of a light shield film are coincided.

As a process for producing a light shield
25 layer used for improving the image quality mentioned

above, that is a black matrix, there are generally known a process for forming a thin metal film, a process comprising coating a photosensitive resin dispersing a pigment such as carbon black, etc. or a
5 photosensitive resin dissolving a dye such as a black dye, etc. on a substrate and exposing the coated film to light using photolithography, and the like.

But the prior art is insufficient for providing optical films having desired properties.

10 BRIEF SUMMARY OF THE INVENTION

It is an object of the present invention to provide an optical film wherein a light shield layer excellent in light shielding properties is accurately placed in a desired position, and said optical film
15 having wide angle of field properties, and an image display apparatus such as a liquid crystal display device installing such an optical film therein.

The present invention provides an optical film comprising an optical element capable of forming
20 spatial distribution of light transmittance, and a light shield layer positioned on an opposite side of the optical element, said light shield layer being composed of a compound which changes light transmittance depending on irradiation of an energy
25 beam, wherein the light transmittance passing the light shield layer is modulated spatially depending on a dose of energy beam.

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The light shield layer can be modified variously for improving light shield properties and angle of field properties.

The present invention further provides an
5 image display apparatus such as a liquid crystal display installing such an optical film.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a series of cross-sectional views for explaining a process for producing the optical film
10 in Example 1.

Fig. 2 is a graph showing a relationship between the distance from a light shield layer to a light diffusion layer and the blurred amount of image.

Figs. 3A to 3D are cross-sectional views for
15 explaining the optical film obtained in Example 2.

Figs. 4A to 4C are cross-sectional views for explaining the optical film obtained in Example 3.

Figs. 5A to 5D are cross-sectional views for explaining the optical film obtained in Example 4.

20 Fig. 6 is a cross-sectional view for explaining the optical film obtained in Example 5.

Figs. 7A and 7B are cross-sectional views for explaining the optical film obtained in Example 6.

Fig. 8 is a cross-sectional view for
25 explaining the structure of the liquid crystal display obtained in Example 7.

Fig. 9 is a rough sketch for explaining the

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rear projection type image display apparatus obtained in Example 8.

DETAILED DESCRIPTION OF THE INVENTION

When a combination of microlenses for
5 enlarging an angle of field of the liquid crystal panel, and a light shield layer (black matrix) for suppressing retroreflection of outer light reflected from the surface of the microlenses is applied to an image display apparatus having wide angle of field
10 properties, for example a liquid crystal display panel, precise positional relation between the microlenses and the positional pattern of light shield layer can exhibit its function for the first time.

But the microlenses for realizing wide angle
15 of field and the light shield film for realizing high contrast are produced independently, followed by combination of them in a later step. Therefore, it is very difficult to align both precisely within several microns.

20 That is, in order to obtain sufficiently wide angle of field, it is necessary to use microlenses having a short focal length. For such a purpose, the curvature radius of microlens is made small, and the height of the microlens per se is made large. These
25 requirements not only make the production of molds and stampers for producing lenses difficult but also cause new problems of failing to obtain desired lens shape

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due to insufficient fluidity of materials, difficulty of mold release of lenses (films) from molds or stampers, and delamination of the produced lenses.

Further, when the lenses are produced by using materials having a high refractive index, usable materials are limited undesirably. For example, the materials are generally limited to acrylic resins, polyesters, polystyrenes, polyolefins, polycarbonates, polyethers, polyether-imides, triacetylcellulose resins, etc., resulting in providing a large obstacle for production of microlenses.

On the other hand, in order to produce the light shield films having high precision, a photolithography method is generally used. That is, after forming a photosensitive layer on a transparent substrate, patterning is conducted by irradiating an energy beam such as ultraviolet light from the photosensitive layer side to produce a light shield layer.

At this time, in order to improve the precision more and more, it is necessary to stick the photosensitive layer to a photo mask at the time of exposure to light. But since the photosensitive layer is black, there arise problems from the viewpoint of production such as sticking of the surface due to stored heat at the time of exposure, insufficient transmission of the energy beam, etc.

When a screen including a lens array sheet

aligning microlenses having a relatively large size of several hundred microns or more used in a conventional rear projection type image display apparatus is produced by using the above-mentioned producing methods, there is no problem whether a conventional extrusion molding or injection molding is used.

But it is difficult to apply these techniques to a recent technology requiring higher precision or usage for liquid crystal display apparatuses having microlenses with several ten micron sizes.

In order to solve such a problem, JP-A 10-39770 discloses a process for producing a microlens sheet which has a lens layer on one side functioning as a fine unit lens aligned body and a pattern on another side corresponding to the fine unit lens aligned body, whereby the microlens array sheet has an optical function layer with a complementary function for individual fine unit lenses.

Such a microlens array sheet can be produced by filling a ultraviolet-curing resin in a mold stamped with a large number of curved surface grooves in parallel, piling a flat plate-like transparent substrate thereon, curing the resin by irradiating ultraviolet light to form a microlens sheet. Then, the side of the flat plate-like transparent substrate having no microlens, a black coating agent is applied, followed by lamination of a transparent positive-working resist thereon by coating. The positive-

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is not allowed to be thin, or it is impossible to obtain a light shield film having excellent light shield properties.

In contrast, according to the present invention, the above-mentioned problems of the prior art are overcome.

According to the present invention, there is provided an optical film comprising an optical element capable of forming spatial distribution of light transmittance, and a light shield layer positioned on an opposite side of the optical element, said light shield layer being composed of a compound which changes light transmittance depending on irradiation of an energy beam, wherein the light transmittance passing the light shield layer is modulated spatially depending on a dose of energy beam.

Further, the light shield layer can be composed of a compound containing silver halide, more concretely, at least Ag (silver) or a compound containing Ag. The light transmittance passing the light shield layer is modulated spatially either by irradiating the compound with an energy beam, or depending on a concentration of silver contained in the light shield layer.

In addition, the light shield layer can be composed of a gelatin material dispersing therein at least silver or a compound containing silver, wherein by irradiating the light shield layer with an energy

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beam, a silver concentration in an irradiated region is made smaller than that in a non-irradiated region.

Still further, the light shield layer can be composed of a gelatin material dispersing therein at least silver or a compound containing silver, and a photosensitive material containing a silver halide which has a property of making a silver concentration in a region irradiated by an energy beam smaller than that in a non-irradiated region.

10 The present invention also provide an optical film comprising an optical element capable of forming spatial distribution of light transmittance, a light shield layer and a light diffusion layer, said light shield layer being positioned between the optical
15 element and the light diffusion layer and composed of a compound which changes light transmittance depending on irradiation of an energy beam, wherein the light transmittance passing the light shield layer is modulated spatially depending on a dose of energy beam.

20 The present invention further provides an optical film comprising an optical element capable of forming spatial distribution of light transmittance, a light shield layer and a light diffusion layer, said light shield layer containing light transmitting
25 regions and light shielding regions, and said light diffusion layer being positioned at least upper side or lower side of the light shield layer corresponding to the light transmitting regions.

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of the present invention mentioned above.

Considering importance of the light shield layer in the present invention, materials for forming the light shield layer are explained in more detail.

5 The materials for forming the light shield layer has a feature in that the light shield layer per se changes to a layer wherein light transmittance is modulated spatially by irradiating an energy beam.

 Concretely, the materials are silver or a
10 compound containing silver, for example, silver bromide which is high in light transmittance before irradiation with an energy beam, while after irradiation with the energy beam, it changes to a layer wherein the light transmittance is modulated spatially by chemical
15 treatment or physical treatment.

 One example of such effective materials is gelatin dispersing therein silver or a compound containing silver atoms, wherein the light transmittance changes by the change of silver
20 concentration. More concretely, a photosensitive material containing a silver halide salt is suitable.

 But a photosensitive material containing a silver halide salt conventionally used cannot be used in the present invention, since the silver contained in
25 the photosensitive material is freed and blacked in that portion.

 In the present invention, the photosensitive material containing a silver halide salt should improve

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The photosensitive layer before forming the light shield layer has a feature in that the light transmittance at the time of exposure to light for patterning is predominantly high compared with a conventional material used for a light shield layer (e.g. carbon black resins, etc.) due to the use of a silver halide salt dispersed in gelatin.

Therefore, in order to form a pattern of
10 black matrix precisely corresponding to the optical
element (e.g. microlenses), it is possible to
sufficiently sensitize a photosensitive layer having a
large film thickness, even in the case of conducting
so-called self alignment exposure wherein the energy
15 beam is irradiated through an optical element. By
subjecting the silver halide salt photosensitive layer
to development and fixation, the black matrix having a
sufficiently high optical density, i.e., a region
having high light transmittance and a light shield
20 region can be formed efficiently.

Further, the light shield layer obtained by using the above-mentioned silver halide salt photosensitive agent has a feature in that a light transmittance ratio of the high light transmittance region to the light shield region is remarkably high and a geometrical level difference between the light shield region and the high light transmittance region is hardly produced. Thus, it is possible to suppress

generation of light scattering harmful for image quality and to form a voidless light diffusion layer for enlarging the angle of field. Further, in the high light transmittance region (the region irradiated with energy beam) formed by a series of steps of exposure, development and fixation, non-uniform components are present and act for scattering the incident light, so that the angle of field is enlarged thereby comparing with a conventional transparent film.

10 Reasons for using the silver halide salt photosensitive materials for producing the optical films of the present invention mentioned above can be summarized as follows.

15 (1) Since the photosensitive materials have high light transmittance and high sensitivity, the film thickness of the photosensitive materials can be made thick, resulting in forming a light shield layer having a high photographic density (optical density).

Concretely, there can be obtained an optical film
20 having a photosensitive layer with a thickness of about 5 μm wherein the optical density is 3 or more in the light shield layer region and the transmittance is 90% or more in the high light transmittance region.

25 (2) Since sensitive wavelengths can be changed optionally by changing the kinds, mixing ratios, etc. of the photosensitive materials, workability can be improved.

(3) There is almost no boundary level difference

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15 In contrast, when a well known photoresist
conventionally used is used, the level difference of 5
 μm or more is produced in order to obtain the same
optical density as mentioned above, resulting in
causing blurred image, lowering of contrast and
20 lowering of brightness due to scattering of the light
for forming image at the boundary.

(4) In the high light transmittance region, a residue of the silver halide salt or a component presumably the gelatin layer is present. Since such a

component has a function of scattering the light without lowering the light transmittance, it exhibits a function of enhancing the effect for enlarging the angle of field of microlenses.

5 Generally speaking, the light shield layer is formed in the silver salt photography as follows. When silver halide in gelatin is exposed to light, photoelectrons are produced, whereby silver ions between lattices form silver atoms. By accumulating
10 this step, there is produced a latent image which is developable. When silver halide particles having the latent image is reacted with a reducing agent such as hydroquinone, the whole particles are reduced to silver atoms to form a black image composed of metallic
15 silver, corresponding to the light shield layer of the present invention (black matrix).

But, in the present invention, it is impossible to use the conventional materials for silver salt photography with blacking mechanism mentioned above. This is because these materials are changed to the black layer, that is, the light shield layer in the region exposed to light, so that it is impossible to form a high light transmittance region in the region where the light is collected using the self alignment exposure technique applying microlens effect.

In order to simplify the production process of the optical films of the present invention and to form the light shield layer (black matrix) with good

precision, it is necessary to improve transmittivity in the region wherein the energy beam is irradiated and to make the non-irradiated region black.

In order to meet the above requirement, the following materials, processes and steps can be used in the present invention to form the light shield region and the high light transmittance region simultaneously using silver halide salts.

(1) After exposing the whole surface of a silver halide sensitizing agent using visible light or ultraviolet light, only the predetermined portions are exposed to red light or infrared light, followed by development and fixation. In this step, there is applied a phenomenon wherein the silver salt latent image formed by previous whole surface exposure to the visible light or ultraviolet light disappears by exposure to red light or infrared light. In order to enhance the effect, it is preferable to add a sensitivity reducing dye such as a triphenylmethane series dye previously to the silver halide sensitizing agent.

(2) The silver halide sensitizing agent preferably contains a special compound so as to make only the exposed portions soluble in an aqueous solution of sodium thiosulfate. Such a special compound includes p-phenylenediamine, ammonia, potassium thiocyanate, thiosulfate salts, or the like.

(3) After exposure to light, the silver halide

latent image produced in the exposed portion is bleached (removed by dissolution), and silver halide in the non-exposed portion is exposed to light again to produce a latent image, followed by development and
5 fixation to give a light shield layer. As the bleaching agent, there can be used an aqueous solution of cerium sulfate, potassium dichromate, potassium permanganate, etc., these compounds being able to dissolve silver.

- 10 (4) There can be employed a process for lowering an optical density (photographic density) by excess exposure to light. According to this process, the halogen produced in silver halide crystals by absorption of light binds to the latent image silver
15 again to consume the latent image silver to reduce the photographic density after development. In this process, in order to exhibit the above-mentioned effect remarkably, there can be used a silver halide photosensitive material matured in the presence of
20 ammonia during the production of the material.

Further, there can be applied to the present invention any photosensitizing technique using silver halide to produce the same phenomena as mentioned above, e.g. modification of sensitizing agents,
25 developing agents, fixers, auxiliary materials, steps such as exposure to light, etc.

As a technique for obtaining a wide angle of field image which is another indispensable subject of

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the present invention, a light diffusion layer is formed on upper surface or lower surface of the light shield layer. By forming the light diffusion layer near the light shield layer (black matrix), it becomes possible to make deterioration of image low and to obtain an image having a wide angle of field. By this, there can be obtained the same effect (wide angle of field) without shortening the focal length of microlenses.

10 The present invention is illustrated in more detail with reference to the following Examples using drawings, which are illustrative, and do not limit the scope of the present invention.

Example 1

15 Fig. 1 is a series of cross-sectional views for explaining a process for producing an optical film of the present invention in the shape of a film. An optical film in the form of a solid substrate (e.g. 5-6 mm thick), not in the form of a flexible film (e.g. about 500 μm in a total thickness), can also be produced in the same manner.

20 After filling an ultraviolet-curing resin between lens grooves in a Ni stamper (not shown in the drawing) having a shape of microlenses and a film for microlenses 1 (100 μm thick) made from a polycarbonate film, the ultraviolet-curing resin was cured by exposing to ultraviolet light to form microlenses 2

(focal length about 120 μ m).

Then, on a black matrix forming film 4 made from a polyester film, a light shield layer forming film 3 obtained by coating gelatin dispersing silver bromide sensitizing agent was laminate bonded. The whole surface of light shield layer forming film 3 was exposed to ultraviolet light from the silver bromide sensitizing agent formed side. Then, self alignment exposure was conducted using parallel infrared light from the microlens array 2 side.

The light shield layer forming film 3 was subjected to conventional development and fixation to form a light shield layer 7 comprising a high light transmittance region 6 which was obtained by collecting the infrared light by the microlenses 2 and a light shield region 5 which was obtained in the region not exposed to the infrared light or exposed to a little dose of the infrared light. Then, a light diffusion layer 8 was formed on the light shield layer 7 using a conventional laminate method. The light diffusion layer 8 was made from a thin film of blend of TAC (triacetylcellulose) and polystyrene beads. The optical film 9 of the present invention was completed by the above-mentioned steps.

As the film or substrate for forming the microlenses 2 or the light shield layer 7, it is preferable to use a material which is transparent to at least visible light. Examples of such a material are

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glass, various kinds of plastic substrates, sheets and films.

As the transparent films, plastic sheets or plastic films are preferably used from the viewpoint of easiness of handling. Typical examples of such plastics are acrylic resins, methacrylic resins, polystyrenes, polyesters, polyolefins, polyamides, polycarbonates, polyethers, polyimides, polyether-imides, polyamide-imides, polyether sulfones, maleimide resins, polyvinyl chlorides, poly(meth)acrylic esters, melamine resins, triacetylcellulose resins, norbornene resins, etc.

Further, it is possible to use copolymers of these resins mentioned above, blended materials of these resins, and cross-linked products obtained from these resins. Among these materials, triacetylcellulose film, polyester film, polyethylene terephthalate film and polycarbonate film are particularly preferable from the viewpoint of a balance of optical properties such as transparency, etc. and mechanical strength.

The process for forming the light shield layer 7 mentioned above is called as an autopositive method, which comprises exposing the whole surface of a silver halide sensitizing agent to visible light or infrared light, irradiating predetermined portions with visible light or infrared light again, followed by development and fixation. The silver salt latent image

formed by exposure is subjected to the application of a phenomenon wherein the silver salt latent image disappears by later irradiation with visible light or infrared light.

5 The wavelength of light used for exposure or
development and fixation is preferably, for example,
550 to 750 nm when the silver halide sensitizing agent
is silver chloride, 650 to 1100 nm when silver bromide
is used. If necessary, a sensitivity reducing dye can
10 be added to the silver halide sensitizing agent to
shift the above-mentioned photosensitive wavelengths.
As the sensitivity reducing agent, there can be used
Phenosafranin, Pinakryptol Green, etc.

In this Example, the light shield layer forming film 3 obtained by coating the silver halide sensitizing agent dispersed in gelatin was used for forming the light shield layer 7 based on the following reasons:

The silver halide sensitizing agent is a
20 photosensitive material obtained by dispersing silver
or a compound containing silver atoms in gelatin and is
capable of modulating the light transmittance with the
change of concentration of the compound. The larger
the Ag concentration becomes, the lower the light
25 transmittance becomes, and the smaller the Ag
concentration becomes, the light transmittance is
improved.

This mechanism can be explained as follows.

When the silver halide in the gelatin is exposed to light, photoelectrons are produced to form silver atoms from the silver ions in the lattices. By accumulating such a step, the silver halide sensitizing agent

5 becomes a latent image which is developable. When the silver halide particles having the latent image is reacted with a reducing agent such as hydroquinone, the whole silver halide particles are reduced to silver atoms to show a black color due to metallic silver.

10 As the silver halide salt sensitizing agent,
there can be used not only commercially available
photographic materials such as silver chloride, silver
bromide, silver iodide, etc., but also techniques
disclosed in the following references as to composi-
15 tions and concentrations of the sensitizing agents,
dispersing amounts in gelatin, auxiliary materials for
photosensitive materials, exposure, development,
fixation, etc.

(1) C. E. K. Mees, T. H. James: The Theory of the
20 Photographic Process, 3rd. ed., Macmillan New York
(1966)

(2) D. A. Spencer: The Focal Dictionary of
Photographic Technology, (1973)

(3) James, T. H.: The Theory of Photographic
25 Process, 4th ed., John Wily & Sons, New York (1977)

(4) J. M. Sturge: Neblette's Handbook of
Photogray and Reprography, Van Nostrand Reinhold (1977)

(5) Shinichi Kikuchi, et al: Kagaku Shashin

In this Example, the light diffusion layer 8 was formed after formation of the light shield layer 7 as shown in Fig. 1, but the light shield layer 7 can be

formed after formatin of the light diffusion layer 8 to obtain the wide angle of field and high contrast.

As to the gap between the two, Fig. 2 shows the relation between the blurred amount of image and the distance (L) between the light shield layer 7 and the light diffusion layer 8 when the optical film 9 of the present invention is installed in a commercially available TFT liquid crystal display panel.

The term "blurred amount of image" means an index showing "distinction" or "discrimination by naked eye" of displayed images or characters, and is expressed by the results obtained by naked eye observation. The smaller the value of blurred amount becomes, the clearer the image or characters becomes.

In this Example, the gap between the light shield layer 7 and the light diffusion layer 8 was made 400 μm or less. When the gap is within this range, no problem arises in usual display. Preferable gap is 150 μm or less, and more preferable gap is 50 μm or less and zero (a state of close contact of both layers).

The optical film shown in Fig. 1 shows 90% or more of light transmittance in the region 6 passing the light and the optical density of 3.5 in the light shield region 5, when the film thickness of the light shield layer 7 is about 5 μm .

Further, since the change of light transmittance in the light shield region 5 and the light passing region 6 formed by the steps of exposure to

5 example, even if the film thickness of the light shield
layer 7 is about 5 to 20 μm , the level difference
between the light shield region 5 and the light passing
region 6 is about 0.5 μm at most, and generally about
0.2 μm .

10 Comparing with the level difference of 5 μm
or more according to a conventional method for forming
the light shield layer using photolithography and
making the optical density of 3.5 or more in the light
shield region, the level difference in this Example is
15 remarkably small, resulting in preventing blurred image
and lowering in contrast and brightness.

Example 2

The microlenses 2 shown in Fig. 3 were formed in the same manner as described in Fig. 1. On a rear side of the film 1 for microlenses, that is, the side opposite to the microlenses formed side, a light shield layer 7 was formed via a light diffusion layer 8 using the so-called photo solubilization method.

This method uses a sensitizing agent
25 containing a mixture of p-phenylenediamine, ammonia,
potassium thio-cyanate, thiosulfate salts, etc. as the
silver halide salt sensitizing agent, and only the

exposed region is made to be dissolved in an aqueous solution of sodium thiosulfate.

After the step of exposing to light from the microlenses 2 side, the same steps as disclosed in Fig. 1 were carried out to produce the optical film 9 shown in Fig. 3A.

As shown in Fig. 3A, it is effective to form the light diffusion layer 8 between the microlenses 2 and the light shield layer 7 for improving the contrast.

In the embodiment shown in Fig. 3B, the light diffusion layer 8 is not formed, but when the light diffusion layer 8 is formed, there can be obtained an optical film 9 having the same structure as shown in Fig. 1.

Further, as illustrated in Fig. 3B, even if the lamination is conducted in the order of the film 1 including microlenses 2, the light shield layer 7, and the light diffusion layer 8, the object of the present invention, that is, the wide angle of field properties and high contrast properties are not damaged.

Fig. 3C shows an optical film 9 wherein a microlens film 1 having microlenses 2 and a light shield film forming film 4 coating a silver halide sensitizing agent thereon are bonded using an adhesive material 10, and a light shield layer 7 is formed by a photo solubilization method.

Fig. 3D shows an optical film 9 obtained by

bonding a microlens film 1 having microlenses 2 with a light shield film forming film 4 coating a silver halide sensitizing agent thereon using an adhesive material 10, forming a light shield layer 7 by a photo solubilization method, and forming a light diffusion layer 8 thereon.

In any cases, the obtained optical films 9 show, for example in the case of the light shield layer 7 being about 5 μm , the light transmittance of 90% or more in the light passing region 6 and the optical density of 3.5 in the light shield region 5.

Example 3

Figs. 4A to 4C show the structure of optical films.

In the optical film shown in Fig. 4A, PET (polyethylene terephthalate) film 1a was used as the film 1 for microlenses.

First, microlenses 2 were formed on the PET film 1a by heated roll transfer using a Ni stamper for forming microlenses, followed by lamination of a light shield layer forming film 4 coating silver halide salt sensitizing agent thereon on the opposite side of the microlenses 2 formed side. Then, a light shield layer was formed by a reverse developing method to obtain an optical film 9.

The reverse developing method is a method for forming a light shield layer comprising bleaching

5 above.

10

15

20

25

Example 4

Fig. 5A to 5D show the structure of optical

Fig. 5A shows an optical film 9 obtained by forming a TAC (triacetylcellulose) film 1b by a conventional extrusion molding, forming microlenses 2

Fig. 5B shows an optical film 9 obtained by bonding a TAC film 11 forming a light diffusion layer 8 thereon to the optical film 9 shown in Fig. 5A.

Fig. 5D shows an optical film 9 obtained by the following process. After forming a light diffusion layer 8 on a light shield layer forming film 4, a silver halide salt photosensitizing agent was coated thereon, followed by bonding a TAC film 1b and the light shield layer forming film 4 using an adhesive 10.

25 The light shield layer 7 was formed in the same manner as mentioned above, but since the silver halide salt sensitizing agent per se is a very thin (e.g. 5 μm), enlargement of the light within the layer of the silver

halide salt sensitizing agent was negligible, said light passing through the light diffusion layer 8 from the microlenses 2 at the time of exposure. That is, the light shield region 5 and the high light passing region 6 were clearly separated in the formed light shield layer 7. In Fig. 5D, numeral 11a denotes a protective film, which can be omitted, if desired.

In any cases, the optical films 9 showed the same good optical properties as those shown in Figs. 1, 3A to 3D and Figs. 4A to 4C. Particularly when the light diffusion layer 8 is formed between the microlenses 2 and the light shield layer 7, the contrast properties are more improved.

Example 5

The optical film 9 shown in Fig. 6 was obtained by forming a light diffusion layer 8a on the areas corresponding to the light passing region 6 formed in the light shield layer in the optical film shown in Fig. 5A. In this case, the image quality obtained through the optical film 9 was sharper than that obtained in the optical film 9 of Fig. 5A.

Example 6

Fig. 7A shows another example of an optical film 9, which was obtained in the same manner as that shown in Fig. 5A, but the light shield layer 7 has the function of the light diffusion layer 8. Fig. 7B is an

enlarged cross-sectional view of the light shield layer 7. As shown Fig. 7B, small balls 12 made from a material having large light transmissivity are mixed in a predetermined amount at the time of coating the silver halide salt sensitizing agent on the light shield layer forming film 4.

The predetermined amount can be determined so as not to damage the light shield properties in the light shield region 5 by the small balls 12 contained in the light shield region 5, when the light shield region 5 and the high light passing region 6 are formed in the light shield layer 7. In this Example, a suitable amount is about 1 to 30% by weight based on the weight of the silver halide salt sensitizing agent.

As the materials for the small balls 12, there can be used inorganic compounds such as glass, silica, titanium oxide, etc., and organic materials such as plastics, e.g. polystyrene, melamine resins (refractive index 1.57), acrylic resins (refractive index 1.49), acrylic styrene resins (refractive index 1.54), polycarbonates, polyethylene, polyvinyl chlorides, silicone resins, etc. It is preferable to use the small balls having a particle size of about 0.1 to 5, or 6 μm .

By the structure mentioned above, the incident light through the microlenses 2 is sufficiently shielded in the light shield region 5, and is emitted outside while dispersed by the small balls 12

in the high light passing region 6, so that the same effects as those obtained by installing the light diffusion layer 8 can be obtained.

Example 7

5 Fig. 7 shows a liquid crystal display apparatus comprising an optical film 9, a liquid crystal cell 13 and a rear illumination means 14 emitting collimate light, wherein the side forming microlenses 2 constituting the optical film 9 and the
10 light emitting side in the rear illumination means are positioned oppositely and sandwiching the liquid crystal cell 13. As the optical film 9, there can be used any ones obtained in Examples 1 to 6.

By a driving means (not shown in the
15 drawing), the liquid crystal cell 13 and the rear illumination means were controlled and the image information displayed by the liquid crystal cell 13 were observed via the optical film 9.

As a result, when the optical film 9 was not
20 installed, the angle of field properties were about $\pm 30^\circ$ against up and down and left and right directions. By installing the optical film 9, the angle of field properties were remarkably improved to about $\pm 60^\circ$ against the up and down, and left and right directions
25 in the range not causing a hue reverse phenomenon.

The angle of field properties were evaluated by defining an angle of field as an angle by which the

intensity of light perpendicular to the liquid crystal cell among light passing through the liquid crystal cell is reduced to a half.

Example 8

5 Fig. 9 shows a rear projection type image display apparatus comprising a projector 15 having a light source and a liquid crystal cell, a mirror 16 for reflecting the light emitted from the projector 15, and a screen for projecting the light reflected by the
10 mirror 16. The screen 17 installs any one of optical films produced in Examples 1 to 6.

By a driving means (not shown in the drawing), the projector 15 having the light source and the liquid crystal cell is controlled, and the image
15 information displayed by the liquid crystal cell is reflected by using the mirror 16. The image information is projected on the screen 17 in an enlarged form.

By using the rear projection type image display apparatus, the angle of field properties are
20 remarkably improved by the microlenses 2 and the light diffusion layer 8, and the contrast properties were remarkably improved by the light shield layer 7 compared with the case of using a screen not installing the optical film 9 of the present invention.

25 In this Example, the screen 17 installing the optical film 9 obtained in any one of Examples 1 to 6 of the present invention was used, but it is possible

to use the optical film per se as the screen 17. For example, as shown in Fig. 3D, the film 1 for microlenses and the light shield layer forming film 4 can be bonded via glass, reinforced plastic, etc.

- 5 Further, the light diffusion layer 7 can be bonded so as to contact with the above-mentioned glass, reinforced plastic, etc.

The present invention is not limited to the Examples mentioned above. Various modifications are possible withing the scope of the present invention. For example, it is possible to form a protective film or a reflection preventing film on the upper side of the light diffusion layer of the optical film. Further, it is possible to use a conventional technique for protecting the optical film of the present invention from ultraviolet light.

The optical film of the present invention comprising the micrelenses, the light shield layer using a silver halide salt sensitizing agent and the light diffusion layer exhibits wide angle of field properties and high contrast properties, and can be applied to image display appratuses to exhibit wide angle of field and high discrimination by naked eye for outer light.

WHAT IS CLAIMED IS:

1. An optical film comprising an optical element capable of forming spatial distribution of light transmittance, and a light shield layer positioned on an opposite side of the optical element, said light shield layer being composed of a compound which changes light transmittance depending on irradiation of an energy beam, wherein the light transmittance passing the light shield layer is modulated spatially depending on a dose of energy beam.

2. An optical film comprising an optical element capable of forming spatial distribution of light transmittance, and a light shield layer positioned on an opposite side of the optical element, said light shield layer being composed of a compound containing at least silver halide, wherein the light transmittance passing the light shield layer is modulated spatially by irradiating the compound with an energy beam.

3. An optical film comprising an optical element capable of forming spatial distribution of light transmittance, and a light shield layer positioned on an opposite side of the optical element, said light shield layer being composed of at least silver or a compound containing silver, wherein the light transmittance passing the light shield layer is modulated spatially depending on a concentration of silver contained in the light shield layer.

4. An optical film comprising an optical element

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capable of forming spatial distribution of light transmittance, and a light shield layer positioned on an opposite side of the optical element, said light shield layer being composed of a gelatin material dispersing therein at least silver or a compound containing silver, wherein by irradiating the light shield layer with an energy beam, a silver concentration in an irradiated region is made smaller than that in a non-irradiated region.

5 An optical film comprising an optical element capable of forming spatial distribution of light transmittance, and a light shield layer positioned on an opposite side of the optical element, said light shield layer being composed of a gelatin material dispersing therein at least silver or a compound containing silver, and a photosensitive material containing a silver halide which has a property of making a silver concentration in a region irradiated by an energy beam smaller than that in a non-irradiated region.

6. An optical film comprising an optical element capable of forming spatial distribution of light transmittance, a light shield layer and a light diffusion layer, said light shield layer being positioned between the optical element and the light diffusion layer and composed of a compound which changes light transmittance depending on irradiation of an energy beam, wherein the light transmittance passing

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7. An optical film comprising an optical element capable of forming spatial distribution of light transmittance, a light shield layer and a light diffusion layer, said light shield layer containing light transmitting regions and light shielding regions, and said light diffusion layer being positioned at least upper side or lower side of the light shield layer corresponding to the light transmitting regions.

9. An optical film according to Claim 1, wherein the optical element is a microlens array.

11. An optical film according to Claim 3, wherein the optical element is a microlens array.

13. An optical film according to Claim 5, wherein the optical element is a microlens array.

14. An optical film according to Claim 6, wherein the optical element is a microlens array.

15. An optical film according to Claim 7, wherein the optical element is a microlens array.
16. An optical film according to Claim 8, wherein the optical element is a microlens array.
17. An optical film according to Claim 6, wherein the light diffusion layer is positioned between the optical element and the light shield layer.
18. An optical film according to Claim 6, wherein the light shield layer and the light diffusion layer are positioned with a gap of 400 μm or less.
19. An optical film according to Claim 6, wherein the light shield layer and the light diffusion layer are positioned with a gap of 150 μm or less.
20. An optical film according to Claim 6, wherein the light shield layer and the light diffusion layer are positioned with a gap of 50 μm or less or without a gap.
21. An optical film according to Claim 8, wherein the small balls have a diameter of 0.1 to 6 μm and contained in the light shield layer in an amount of 1 to 30% by weight.
22. An optical film according to Claim 1, wherein the optical film takes a shape of a film or a substrate.
23. An optical film according to Claim 2, wherein the optical film takes a shape of a film or a substrate.
24. An optical film according to Claim 3, wherein

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the optical film takes a shape of a film or a substrate.

25. An optical film according to Claim 4, wherein the optical film takes a shape of a film or a substrate.

26. An optical film according to Claim 5, wherein the optical film takes a shape of a film or a substrate.

27. An optical film according to Claim 6, wherein the optical film takes a shape of a film or a substrate.

28. An optical film according to Claim 7, wherein the optical film takes a shape of a film or a substrate.

29. An optical film according to Claim 8, wherein the optical film takes a shape of a film or a substrate.

30. A liquid crystal display comprising a liquid crystal cell, a rear illumination means for emitting collimate rays, and an optical film, wherein the liquid crystal cell is sandwiched between the rear illumination means and the optical film.

31. A liquid crystal display according to Claim 30, wherein the optical film is any one of Claims 1 to 29.

32. A rear projection apparatus comprising a projector containing a light source and a liquid crystal cell, a mirror for reflecting a light from the

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projector, and a screen for projecting the light reflected by the mirror, said screen being composed of an optical film of any one of claims 1 to 29.

ABSTRACT OF THE DISCLOSURE

An optical film comprising microlenses, a light shield layer and a light diffusion layer, wherein, for example, the light transmittance passing through the light shield layer is modulated depending on changed concentrations of silver or a compound containing silver dispersed in gelatin in the light shield layer, has wide angle of field properties and high contrast properties, and can be applied to image display apparatuses such as a liquid crystal display to improve angle of field properties, contrast properties and to prevent image deterioration against outer light.

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FIG.1

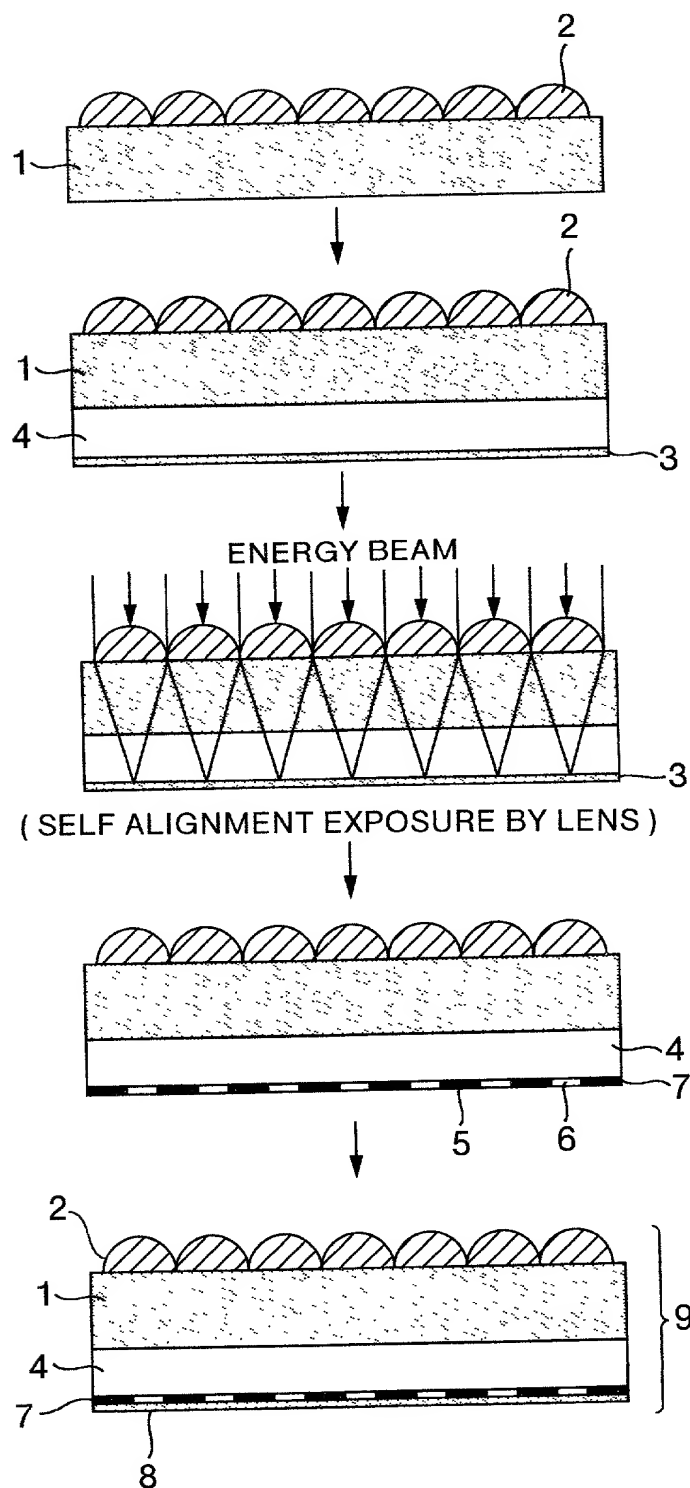


FIG.2

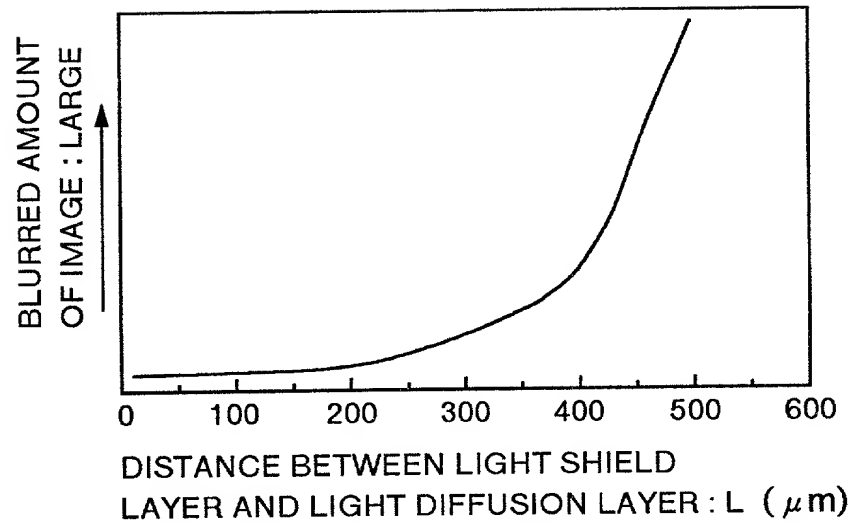


FIG.3A

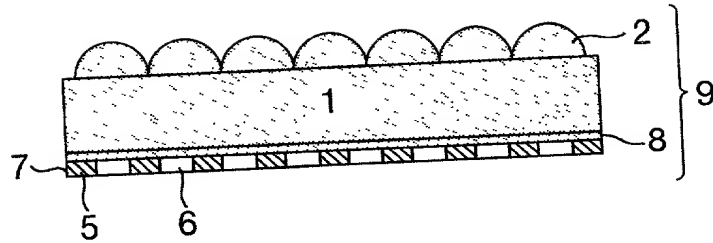


FIG.3B

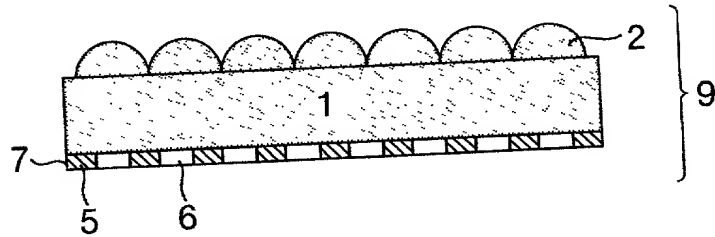


FIG.3C

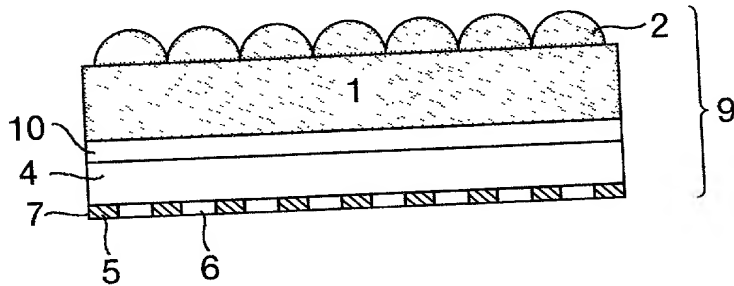


FIG.3D

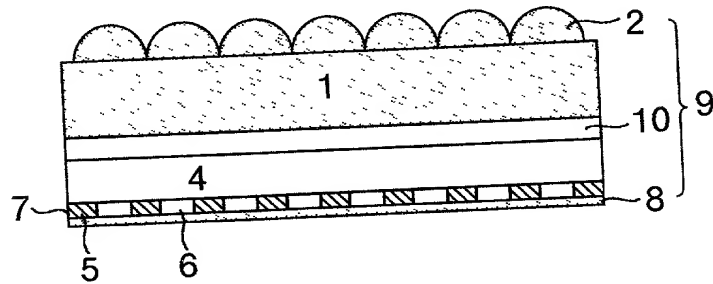


FIG.4A

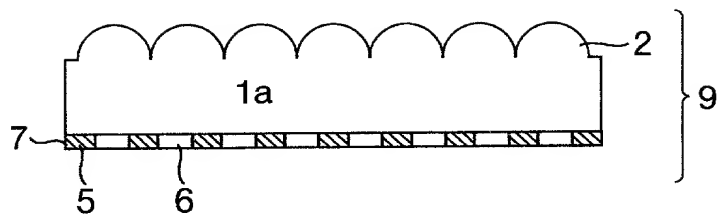


FIG.4B

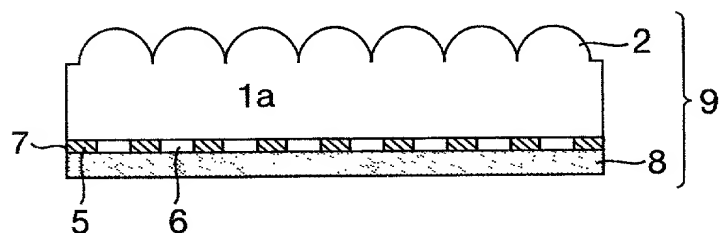
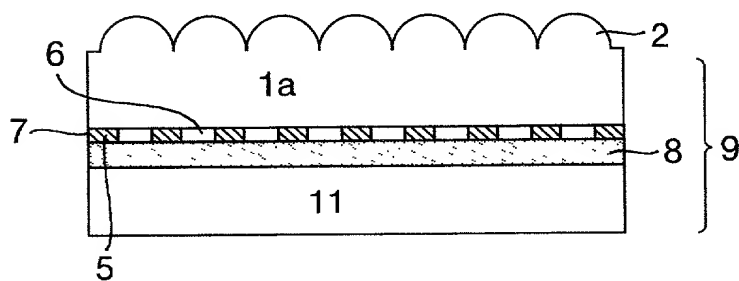


FIG.4C



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FIG.5A

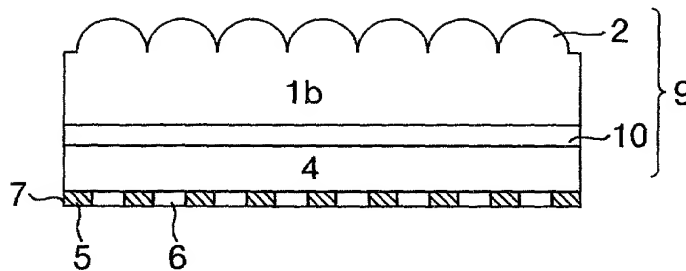


FIG.5B

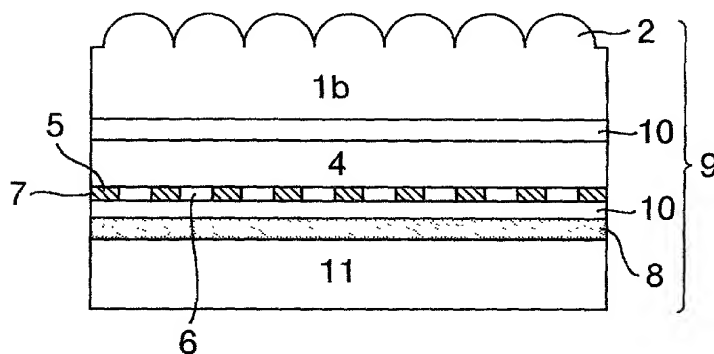


FIG.5C

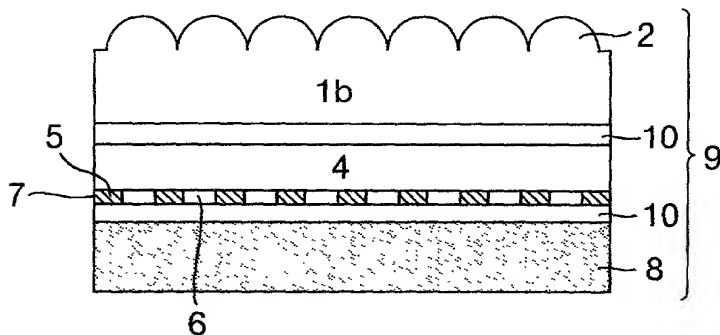


FIG.5D

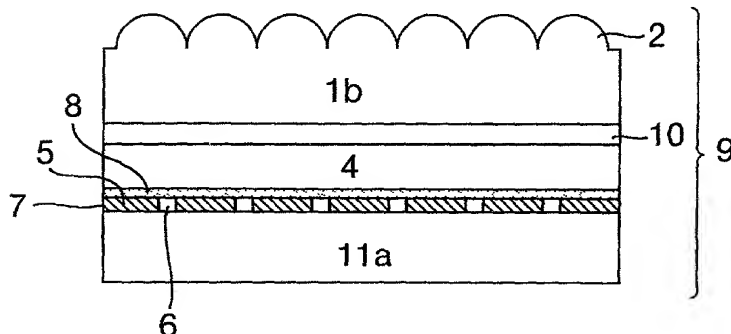


FIG.6

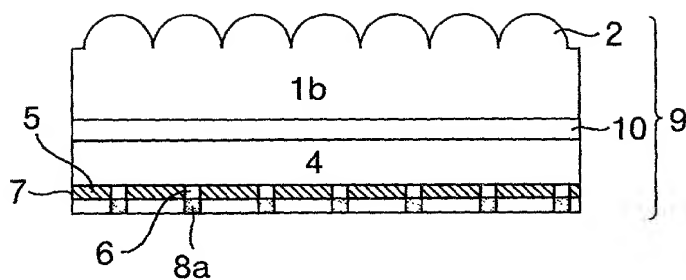


FIG.7A

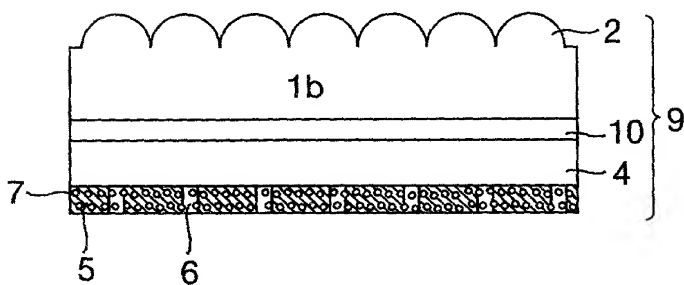


FIG.7B

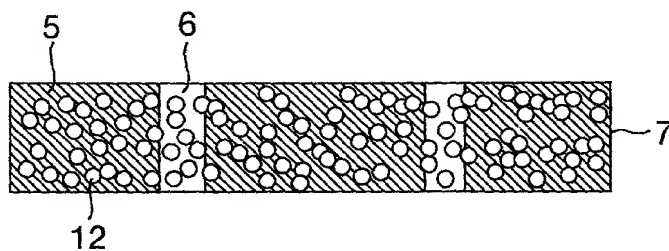


FIG.8

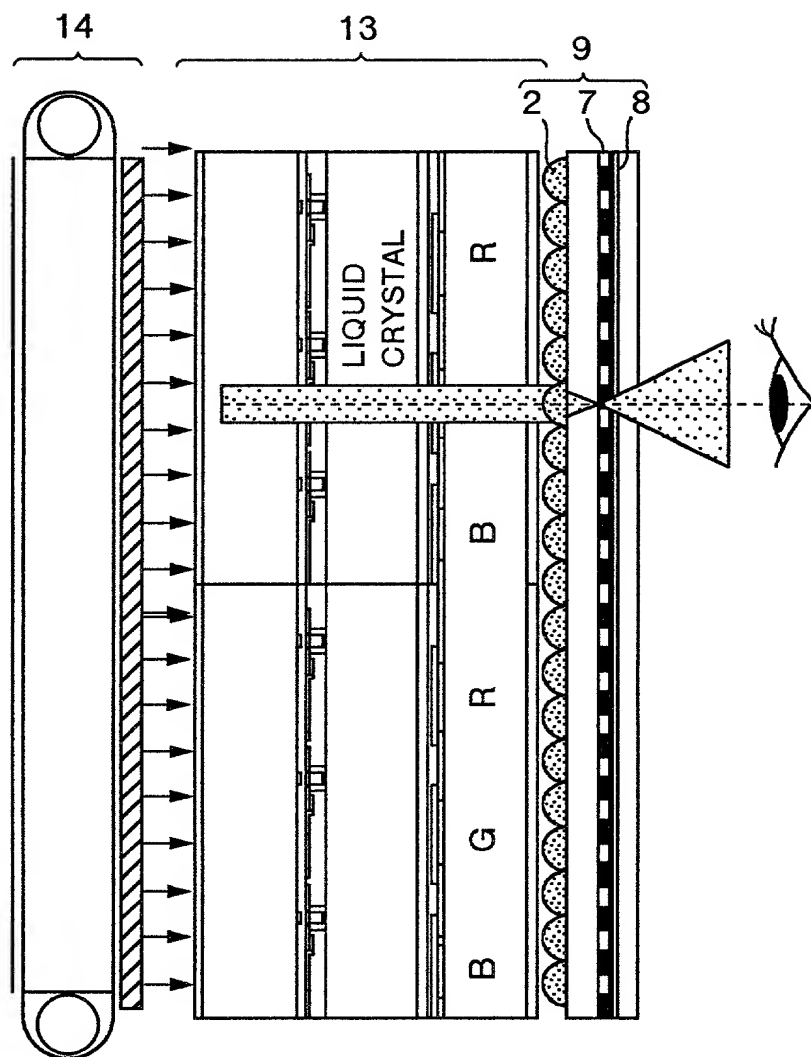


FIG.9

